

# MSHA's Guide to Equipment Guarding

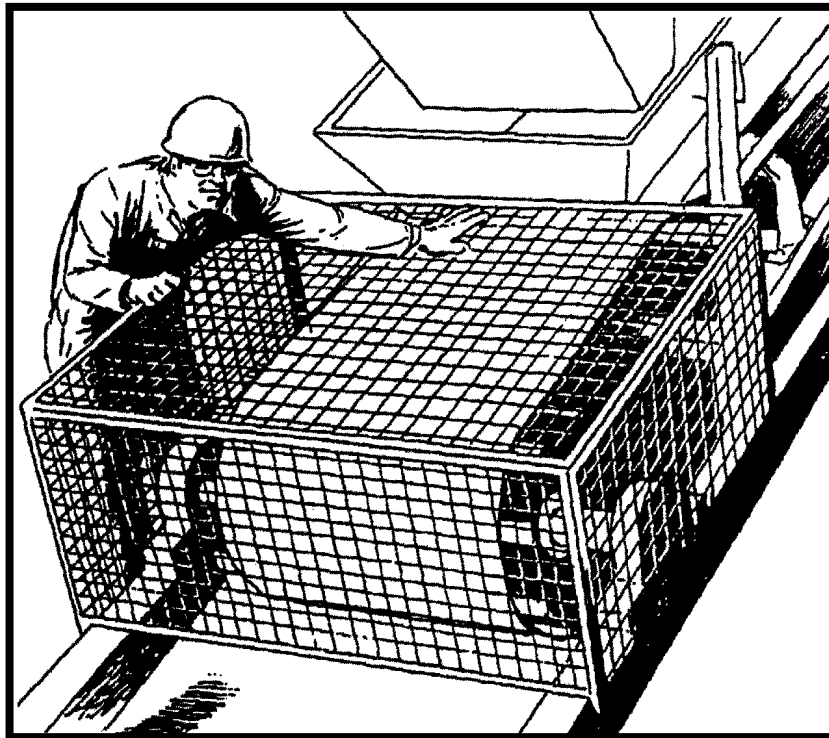
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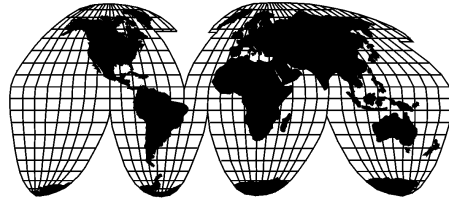
U.S. Department of Labor  
Mine Safety and Health Administration

Other Training Material  
OT 3

Revised 2000



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U.S. Department of Labor  
Alexis M. Herman  
Secretary

Mine Safety and Health Administration  
J. Davitt McAteer  
Assistant Secretary

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## INTRODUCTION

This guide is provided to assist the mining community with designing, installing, and maintaining equipment guards to ensure that miners are not exposed to hazardous moving machine parts.

The illustrations in this booklet show specific applications of guards using expanded metal. This was done to simplify the drawings. In no way should this be misunderstood to mean that all guarding must utilize expanded metal. However, the use of expanded metal or sizing screen does have several advantages such as:

- ✓ The components guarded can be inspected without removing the guard.
- ✓ Grease fittings and oil cups can be placed through the openings without cutting large holes in the guard. (Large holes should not be cut in guards to gain access to grease fittings. Grease lines should be extended so that lubrication can be accomplished from a safe location outside the guard.)
- ✓ At most operations this material is readily available.
- ✓ In certain circumstances, the use of expanded metal guards serves to allow smaller particles of spilled material to pass through the guard with minimal buildups.

**This booklet contains examples of commonly used equipment guards. Alternative designs are acceptable provided the requirements of the guarding standards are met. However, MSHA recognizes that there may be site specific complex situations which require unique guard design and installation.**

## BASIC PRINCIPLES OF GUARDING

MSHA's regulations require that moving machine parts be guarded to protect persons from contacting gears, sprockets, chains, drive, head, tail and takeup pulleys, flywheels, couplings, shafts, fan blades, saw blades, and similar moving parts that can cause injury. Also, the regulations require that overhead drive belts be guarded where the whipping action of a broken belt could be hazardous to persons, and that unguarded conveyors next to travelways be equipped with emergency stop devices to readily deactivate the drive motor. [ref. 30 CFR 56/57.14107, 56/57.14108, 56/57.14109, 56/57.14112, 75.1722, 77.400, 77.1607(cc)]

**NOTE: In metal/nonmetal, railings positioned to prevent persons from falling on or against the conveyor may be used in lieu of emergency stop devices.**

Many accidents result from persons coming in contact with exposed moving machine parts. Persons can be protected by the proper installation and maintenance of guards. When designing guards, all possible **contingencies should be considered including acts of thoughtlessness and foolhardiness**. The opinions of the operator of the machine, the supervisors, and maintenance personnel could enhance design and construction. **Guards cannot be removed unless the hazards they guard against have been eliminated.**

An effective machine guard must:

- ✓ Be considered a permanent part of the machine or equipment.
- ✓ Be installed as close to the machine part as feasibly possible.
- ✓ Prevent access to all moving machine parts.
- ✓ Be designed for the specific job and specific machine.
- ✓ Be designed and fabricated - to the extent practical - to such dimensions and weights that one person is able to physically install and remove the individual guard components.
- ✓ Be constructed and maintained to withstand vibration and shock during normal operation.
- ✓ Not present a hazard in itself.

Materials for guards should be carefully selected. For most installations, guards constructed of metal framing with sheet metal, perforated metal, expanded metal, or heavy wire mesh are more satisfactory than those of other materials.

Moving machine parts may be guarded in a number of ways, several of which may be satisfactory. The selection of a guarding method to be used may depend upon a number of factors such as space limitations, production methods, and frequency of use. **Moving machine parts must be guarded rather than restricting access to the area by installing railings, chains, cable, or gates.**

An "area guard" is any guard which covers more than one independently controlled component **or** is large enough to permit a person to place themselves between the moving machine parts and the guard. In several instances, moving machine parts of multiple independently controlled components (i.e., two or more conveyor tail pulleys) have been enclosed together. Persons can enter the area to perform maintenance or cleaning on one of the tail pulleys, while the other(s) remain in operation. A single area guard which encloses multiple moving machine parts does not provide the protection required to be in compliance with the guarding standard.

**Area guarding is not acceptable.**

Examples of area guards:

- ✓ Gates, doors, or barriers constructed across openings into areas that contain multiple tail pulleys, drive belts, drive pulleys, and other moving machine parts.
- ✓ Fencing constructed around areas that contain more than one independently controlled pulley, shaft, or drive belt. Some of these installations may be provided with a gate that has an interlocking system that will de-energize the components within when opened. This is not an acceptable application in lieu of guarding.
- ✓ A guard that can be entered by persons enabling them to get between the inner perimeter of the guard and the moving machine parts.

**Historically, if space is provided between a guard and a hazard, someone will eventually go there and be exposed to the hazard.**

## FIGURES 1 and 2

Figure 1 shows a tail pulley with an inadequate guard. The rear and top of the pulley are fully exposed providing access to multiple moving machine parts.

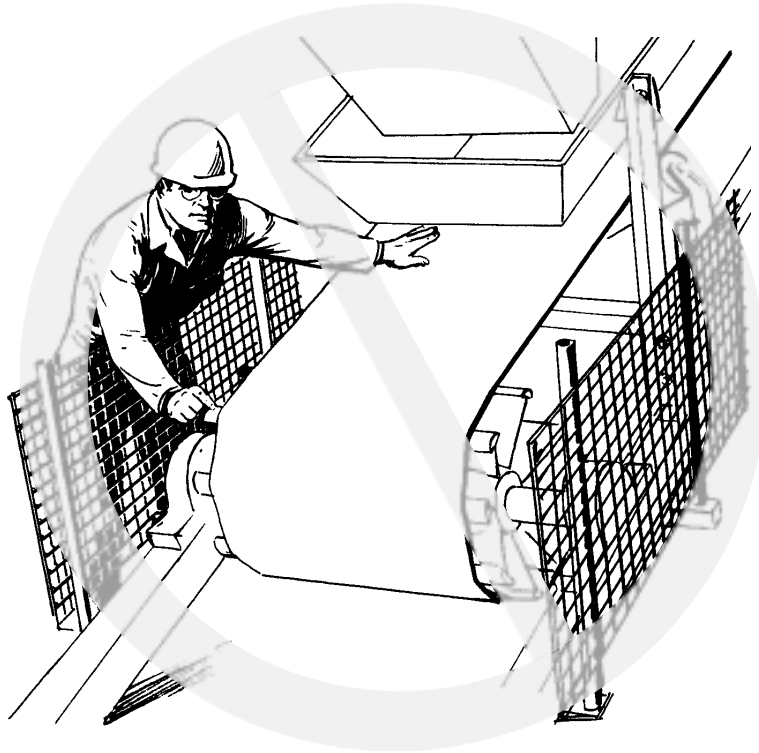


Figure 1

The pulley must be totally guarded as shown in Figure 2.

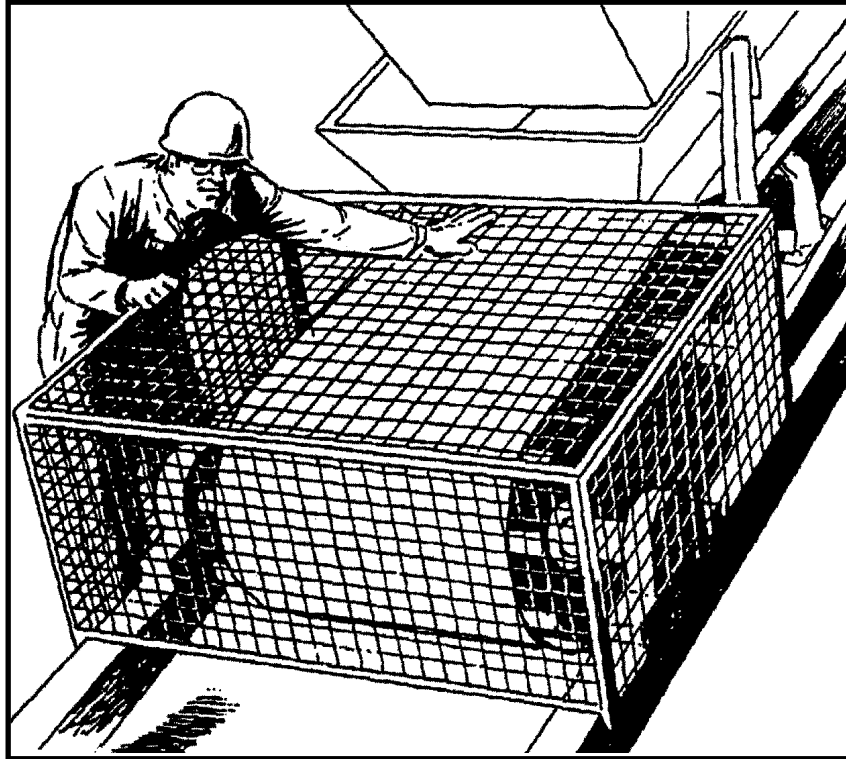


Figure 2



### FIGURE 3

Figure 3 shows an elevated tail pulley. The underside of the pulley is accessible and required to be guarded. The guards should have openings large enough to allow fines to fall through, but not large enough for a person's hand or finger to reach the moving part.

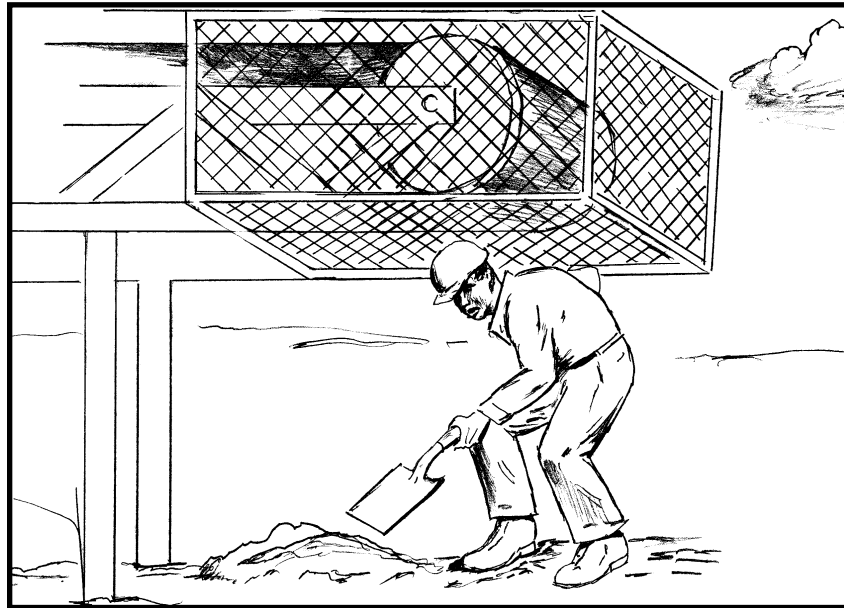
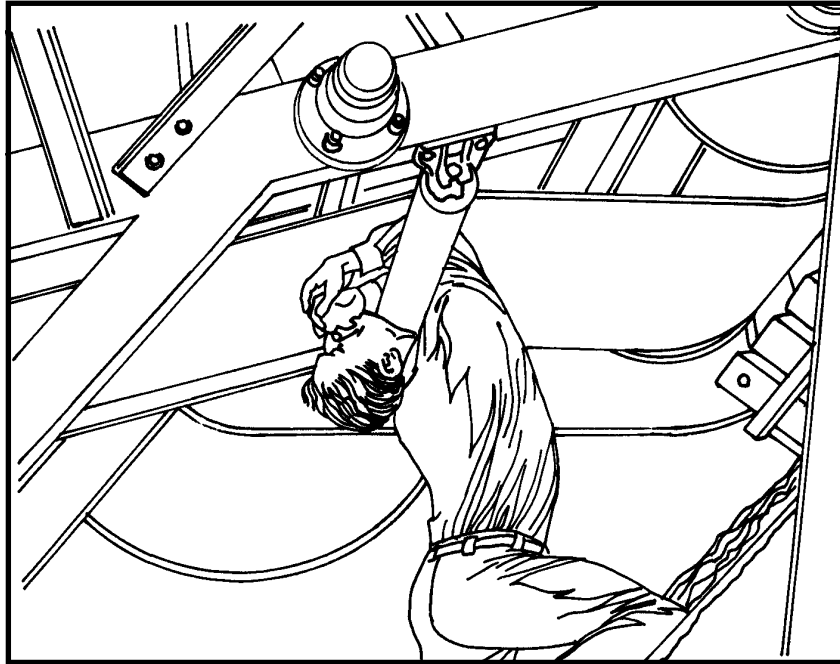


Figure 3

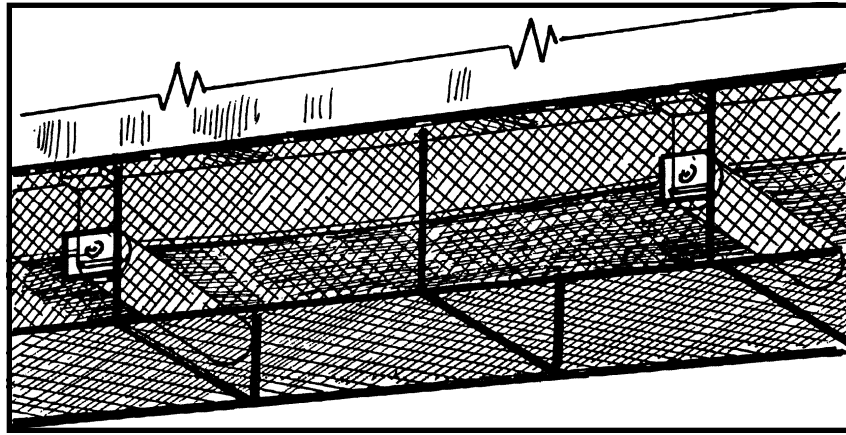
#### **FIGURES 4, 5, 6, and 7**

The reason for guarding return idlers is shown in Figure 4. They must be guarded if someone could contact them while working or passing underneath the belt. It is reasonable to expect these types of accidents where persons or tools can contact the idlers.



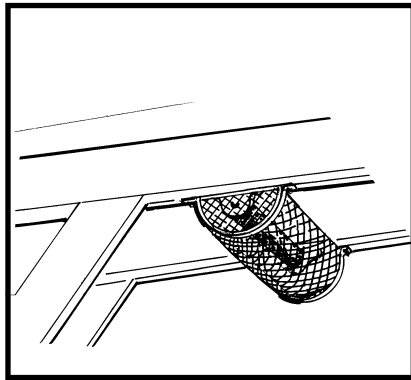
**Figure 4**

Figure 5 shows one method of guarding return idlers. Notice that grease fittings can be accessed without removing the guard. The mesh openings should be large enough to allow fines to fall through, but not large enough for a person's hand or finger to reach the moving part.

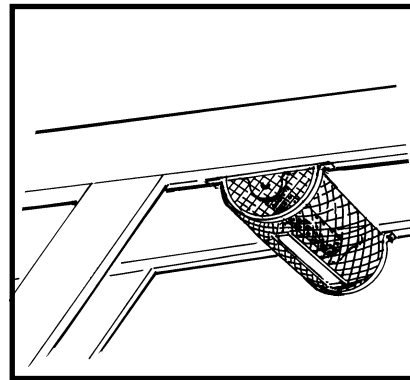


**Figure 5**

Figures 6 and 7 show another acceptable way of guarding return idlers. When this type of guard is used, the gap between the return belting and the guard should be minimized.



**Figure 6**



**Figure 7**

**FIGURES 8 and 9**

An unguarded head pulley and drive unit are shown in Figure 8.



**Figure 8**

Figure 9 shows the guard in place.

The head pulley guard is extended so the moving machine parts cannot be contacted.

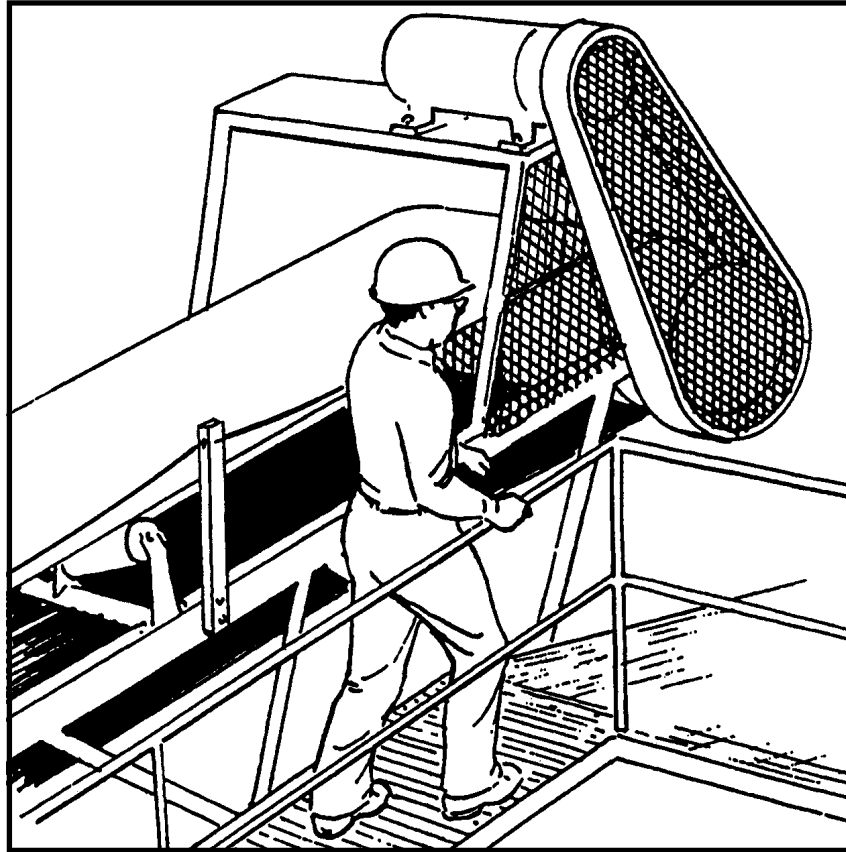


Figure 9

## FIGURE 10

An emergency stop cord along a conveyor belt with a walkway is shown in Figure 10.

The stop cord must be located so that it can be reached by a person who falls on or against the belt. The stop cord must also be sufficiently tight to assure the conveyor drive motor will be readily deactivated when the cord is pulled. The stop cord can be used when the walkway is part of the conveyor, or where persons travel alongside unguarded conveyors at ground level.

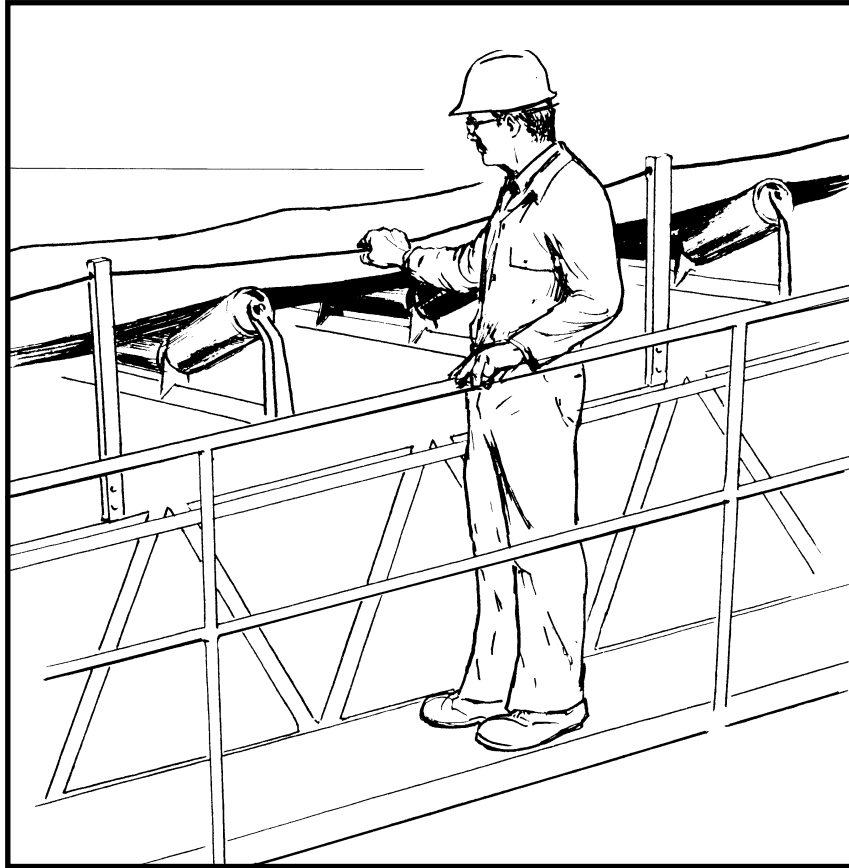
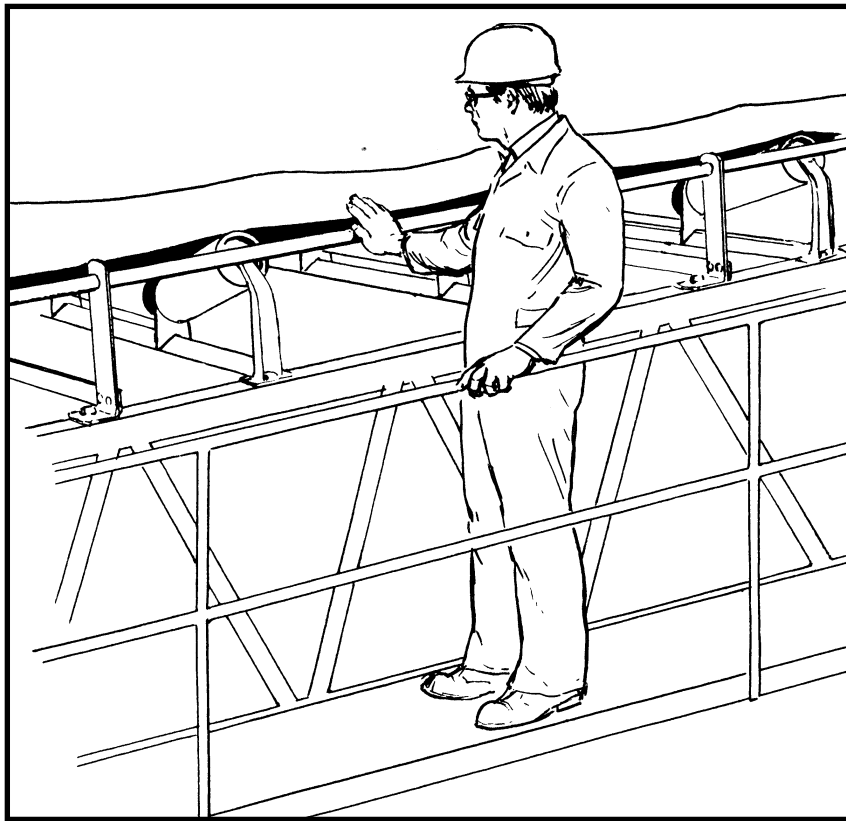


Figure 10

**FIGURE 11**

In this drawing, a railing is installed along the conveyor in lieu of an emergency stop cord. The railing is positioned to prevent persons from falling on or against the conveyor. In cases where cables are used for railings, they must be kept tight and free of burrs or other hazards that could cause injury.

The use of railings or cables in lieu of emergency stop cords does not meet the requirements of the coal regulations.



**Figure 11**

## FIGURES 12 and 13

An unguarded takeup pulley is shown in Figure 12. The structure of the conveyor is not considered a guard.

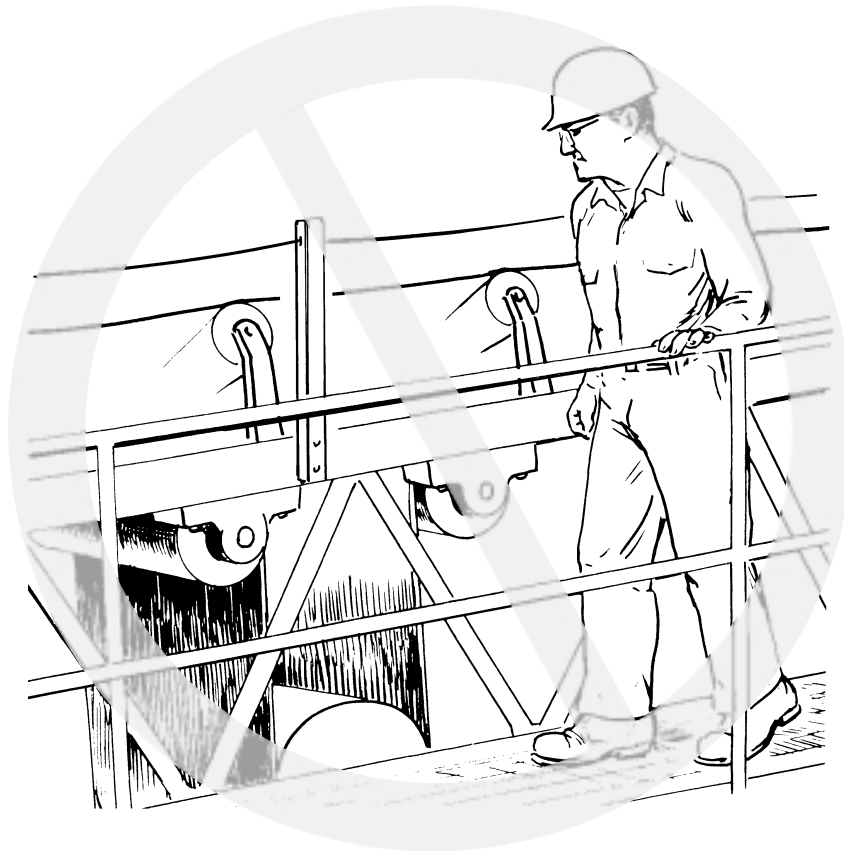


Figure 12



A simple guard (as shown in Figure 13) can be installed to prevent access to the moving machine parts.

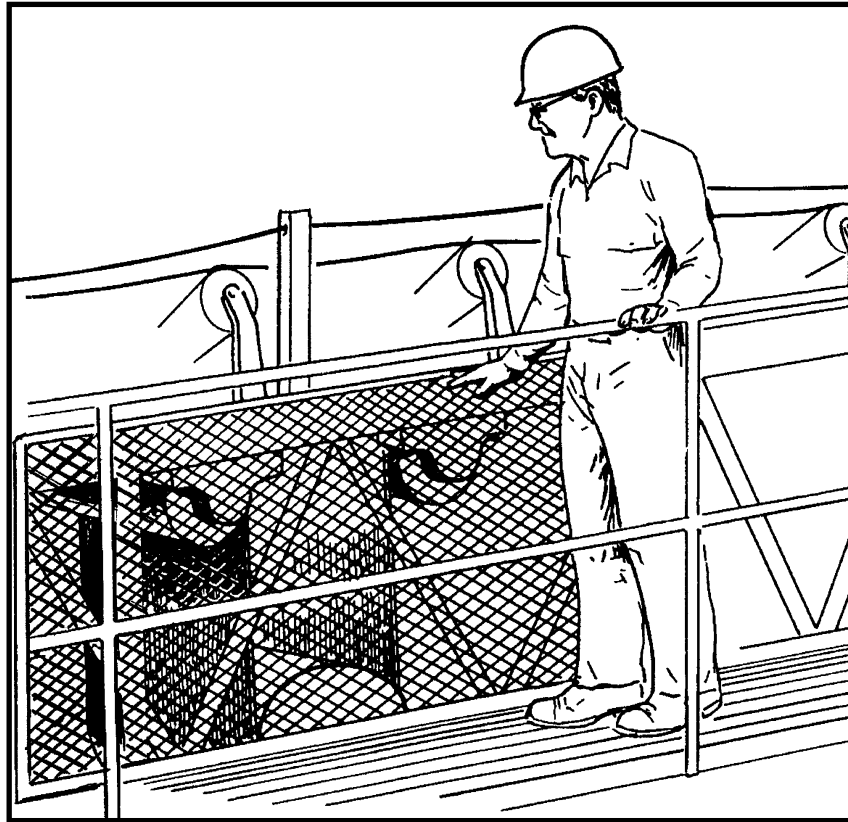


Figure 13

# FIGURE 14

Serious injuries have occurred while manually applying belt dressings to moving belts. Belt dressings must not be applied using brushes or other tools while belts are in motion. Pressurized type applicators may be used to apply dressings from outside the guard, as shown in Figure 14.

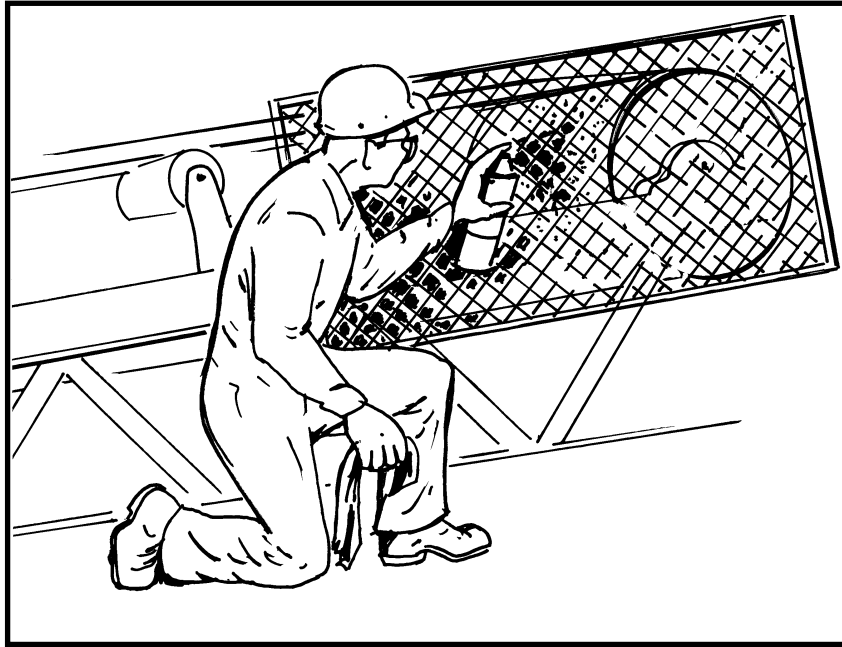


Figure 14

## FIGURES 15 and 16

The moving machine parts of takeup pulleys are normally located a sufficient distance above the ground to prevent contact, and are therefore considered "guarded by location." However, they are normally equipped with heavy counterweights which often allow access below them. The guard in Figure 15 prevents access to this suspended load hazard.

Figure 16 shows a suspended conveyor with the guides blocked by a bar to prevent the counterweight from dropping to ground level in case of belt breakage. Cables, for additional safety, are fastened to the structure. This arrangement is acceptable only if the bottom of the frame is guarded by location.

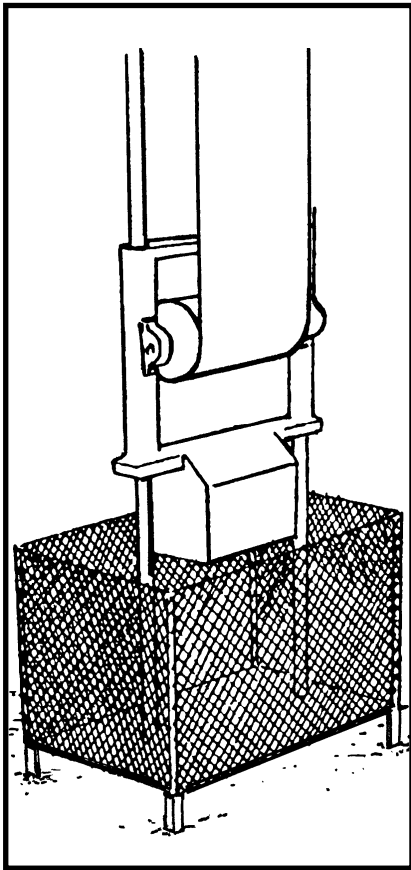


Figure 15

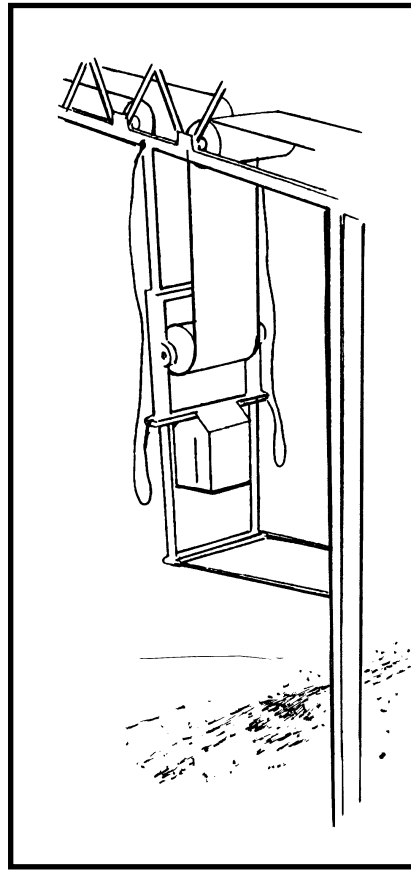


Figure 16

## FIGURES 17 and 18

Drive shafts with protruding set screws, keys and key ways present obvious hazards (Figure 17). However, even "smooth" shafts can present a hazard, such as by grabbing clothing. Except where shafts are guarded by location, all rotating shafts must be guarded. (Example: Figure 18).

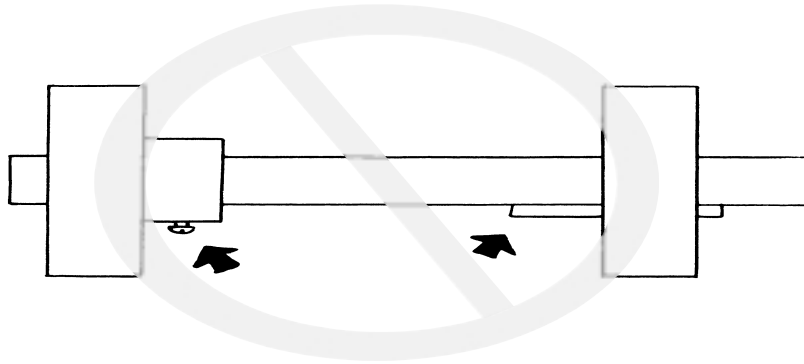


Figure 17

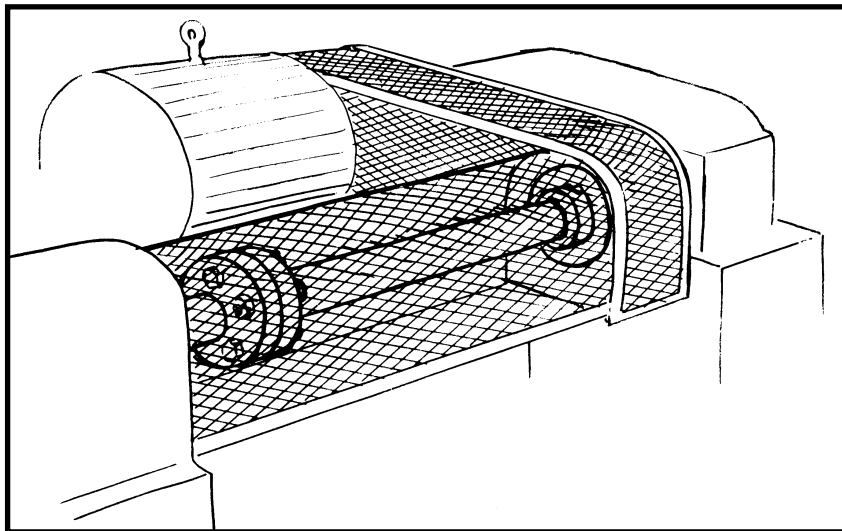


Figure 18

## FIGURES 19 and 20

A power take-off shaft with universal joints is shown in Figure 19.

This type of shaft is primarily used for portable crushing equipment and can be guarded as shown in Figure 20.

The guard is constructed of two halves, totally enclosing the drive shaft.

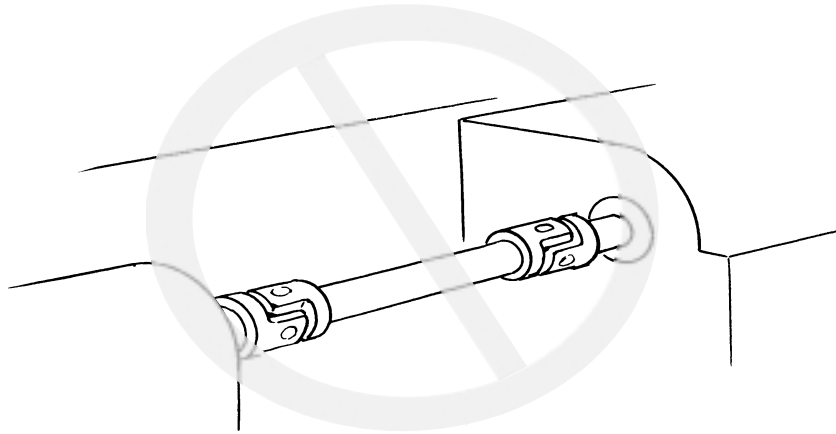


Figure 19

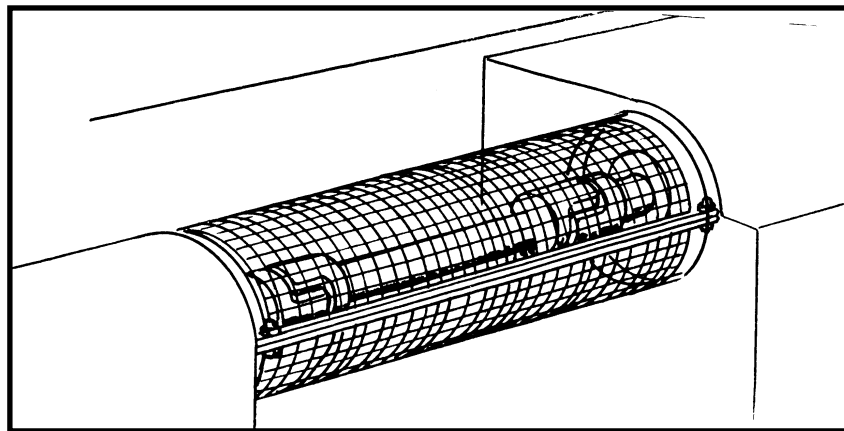


Figure 20

## FIGURES 21 and 22

A drive coupling is shown in Figure 21. Couplings of this type should be totally enclosed as shown in Figure 22.

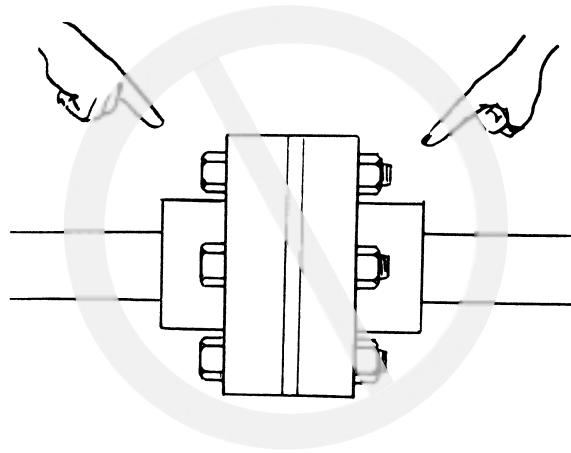


Figure 21

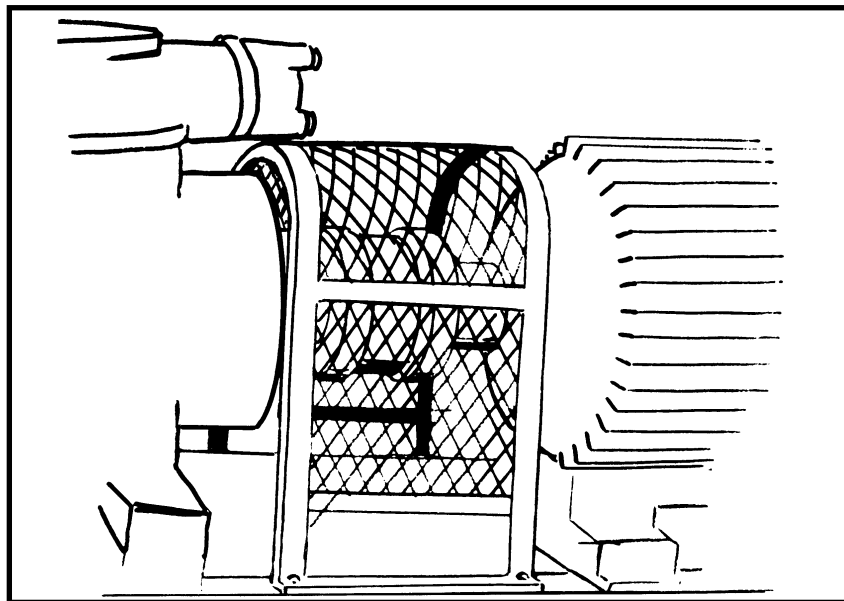


Figure 22

## FIGURES 23 and 24

A guard for a drive belt and pulleys is shown in Figure 23. This guard is inadequate because the belt and pulleys can still be contacted from the back.

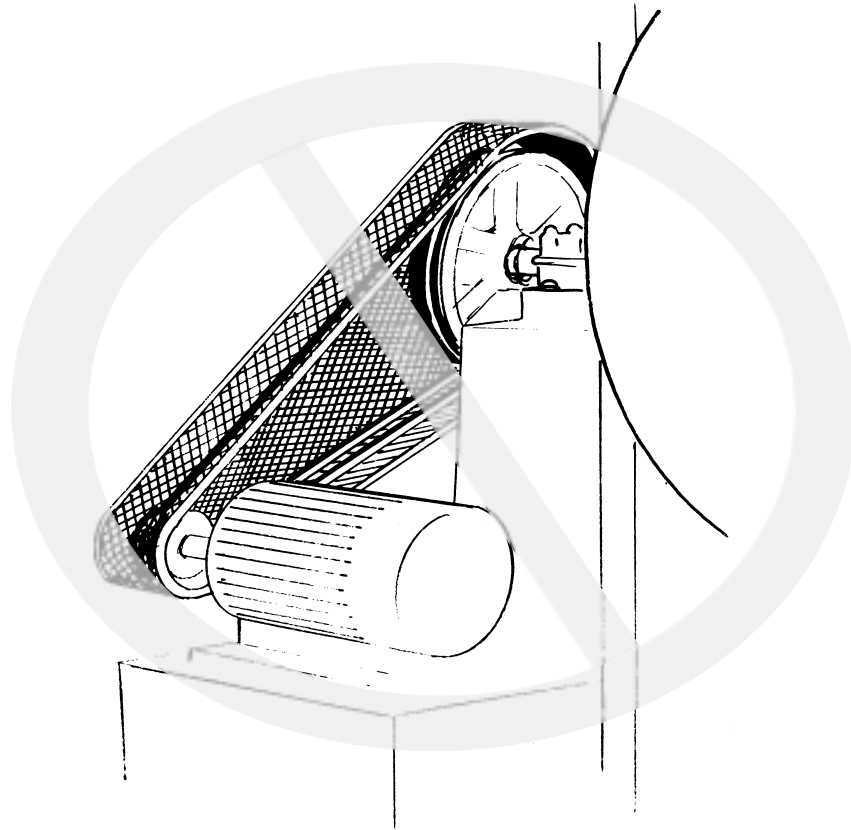


Figure 23

Where contact is possible from both sides, the belts and pulleys must be totally enclosed as shown in Figure 24.

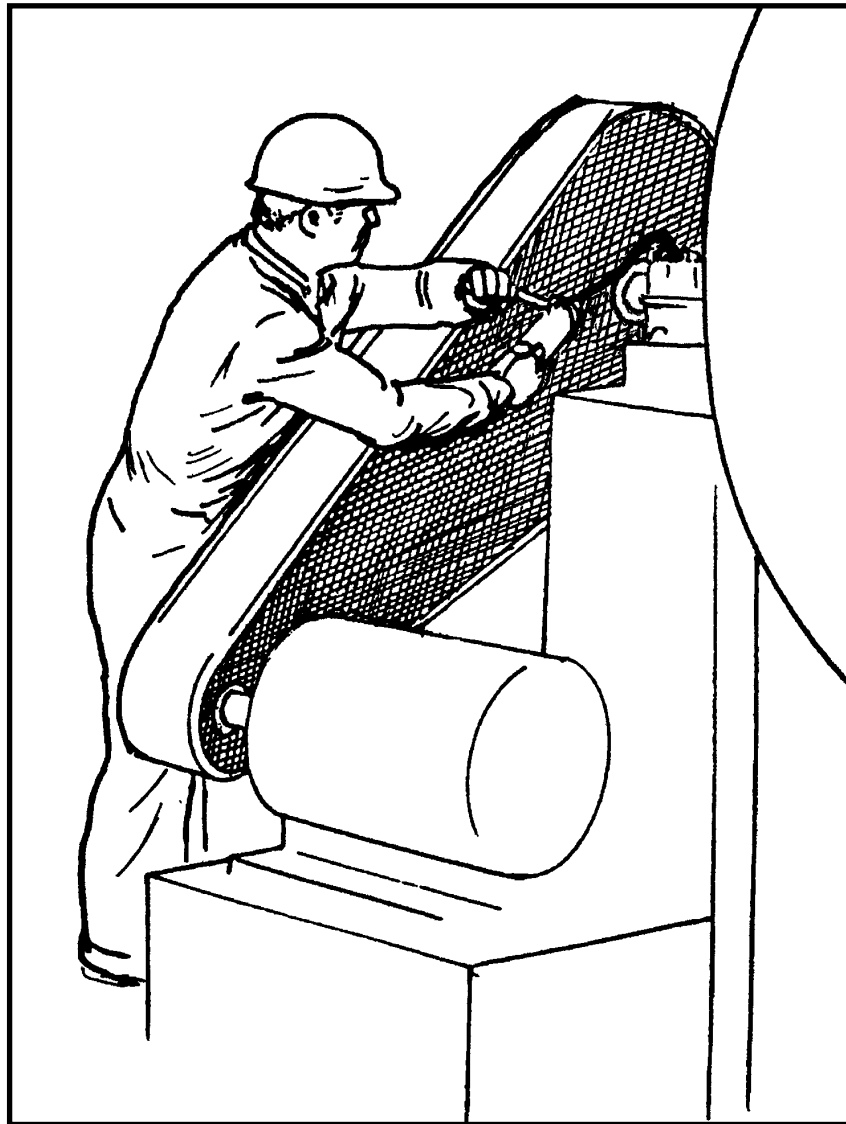


Figure 24



## FIGURES 25 and 26

Whenever hazards to persons working or traveling nearby are created by belt breakage as shown in Figure 25, a guard must be provided to contain the broken belt. An example is shown in Figure 26.

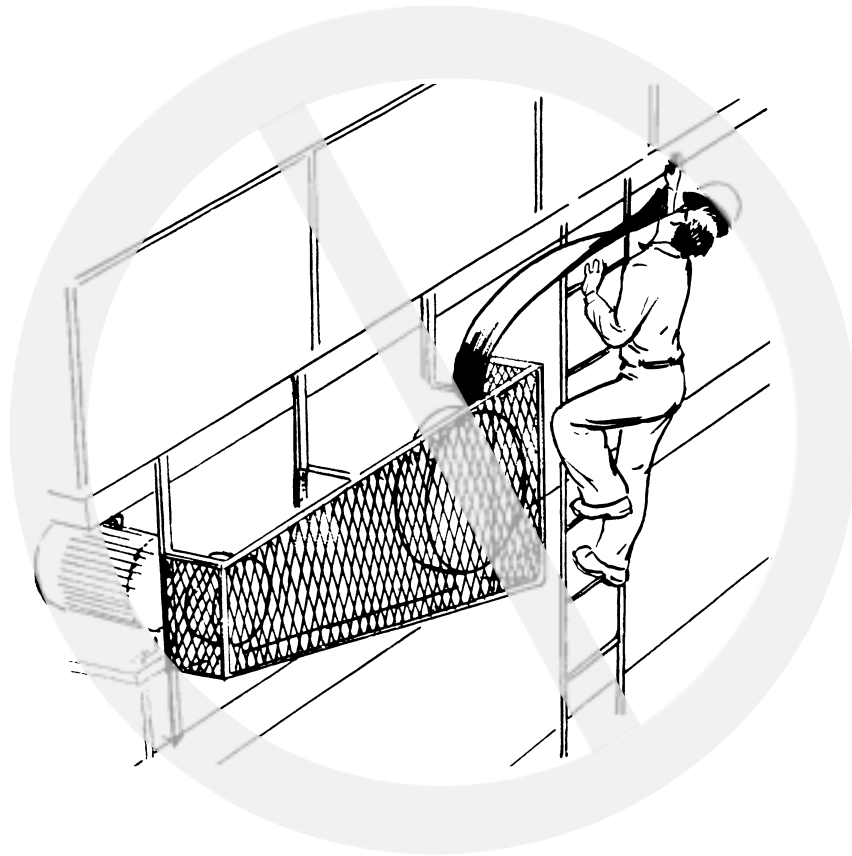


Figure 25

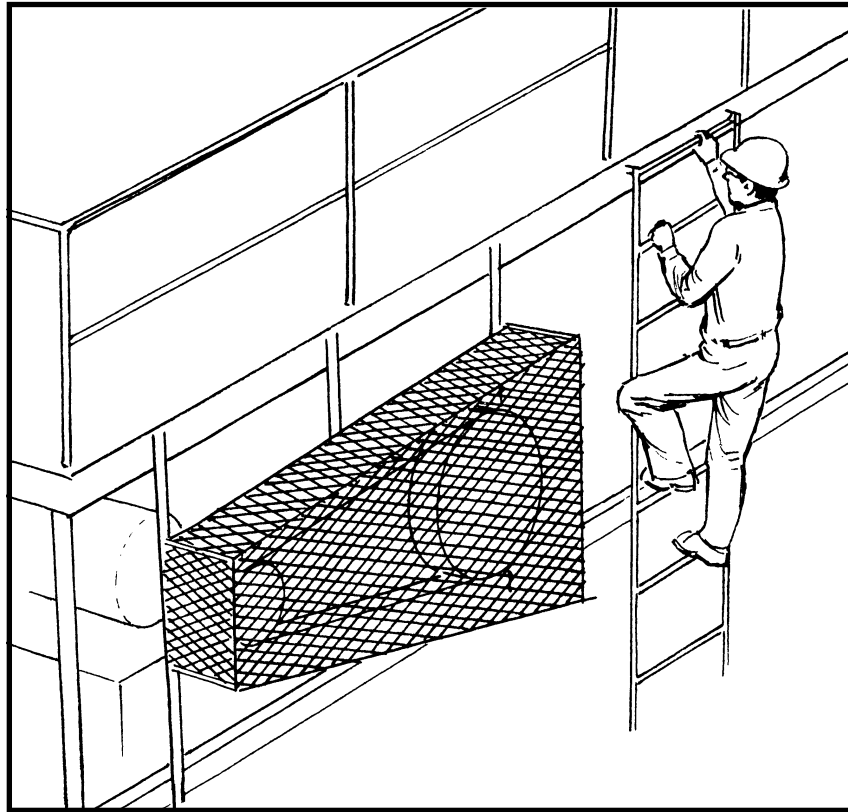


Figure 26

## FIGURE 27

Protruding shaft ends that pose a hazard must be guarded. Generally, smooth shaft ends protruding less than one-half the shaft diameter need not be guarded. All shaft ends that are not smooth, regardless of the distance they protrude, must be guarded.

An effective way of guarding protruding shaft ends is shown in Figure 27. A simple sleeve with an end cap is placed over the shaft, thereby preventing any contact.

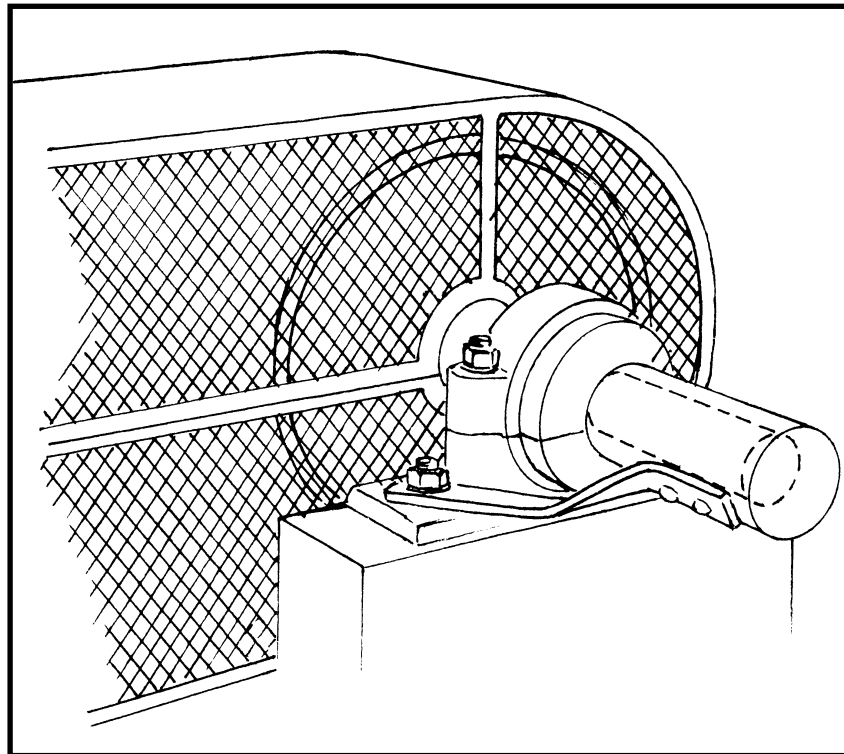
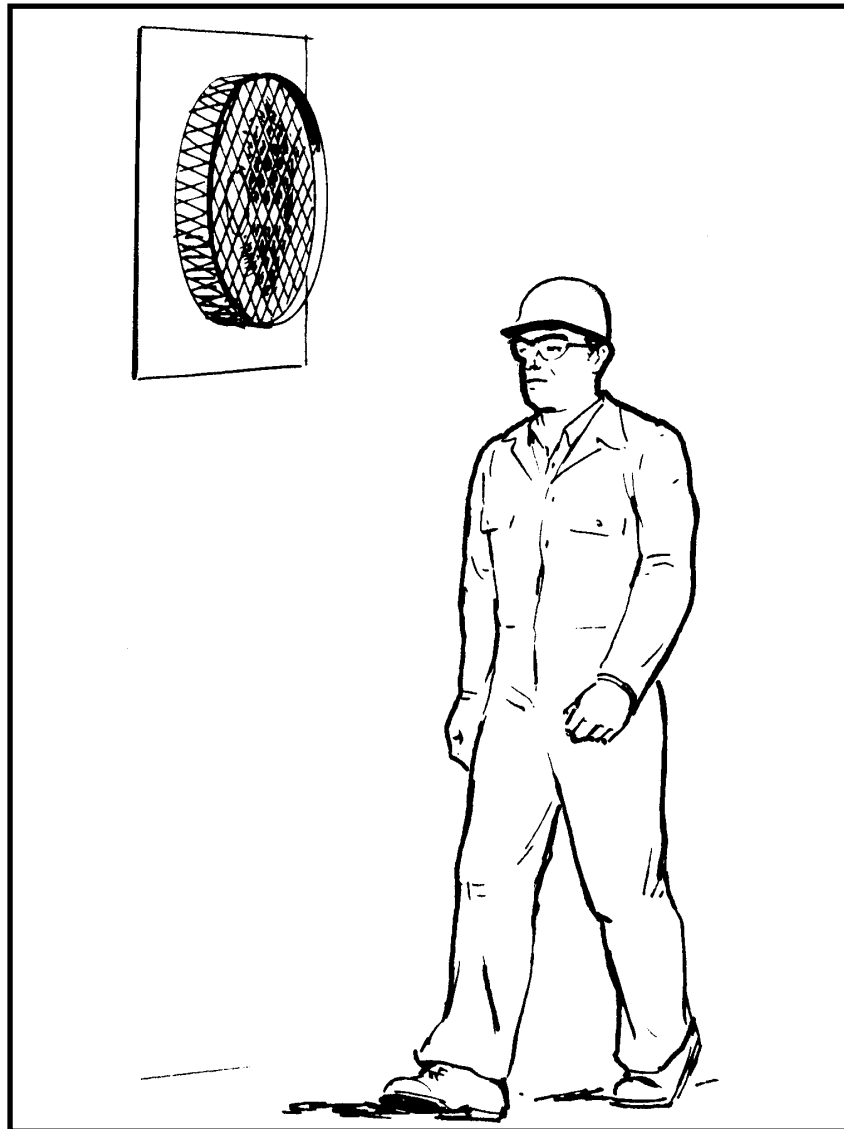


Figure 27

**FIGURE 28**

Fan blades must be guarded where they can be contacted.



**Figure 28**

### FIGURES 29, 30, and 31

Figure 29 shows a flywheel guarded by location. A build-up of material can, at times, place the flywheel within easy reach, as shown in Figure 30. Therefore, the flywheel must be guarded.

Where it is not necessary to totally enclose the flywheel, a guard as shown in Figure 31 may be used.

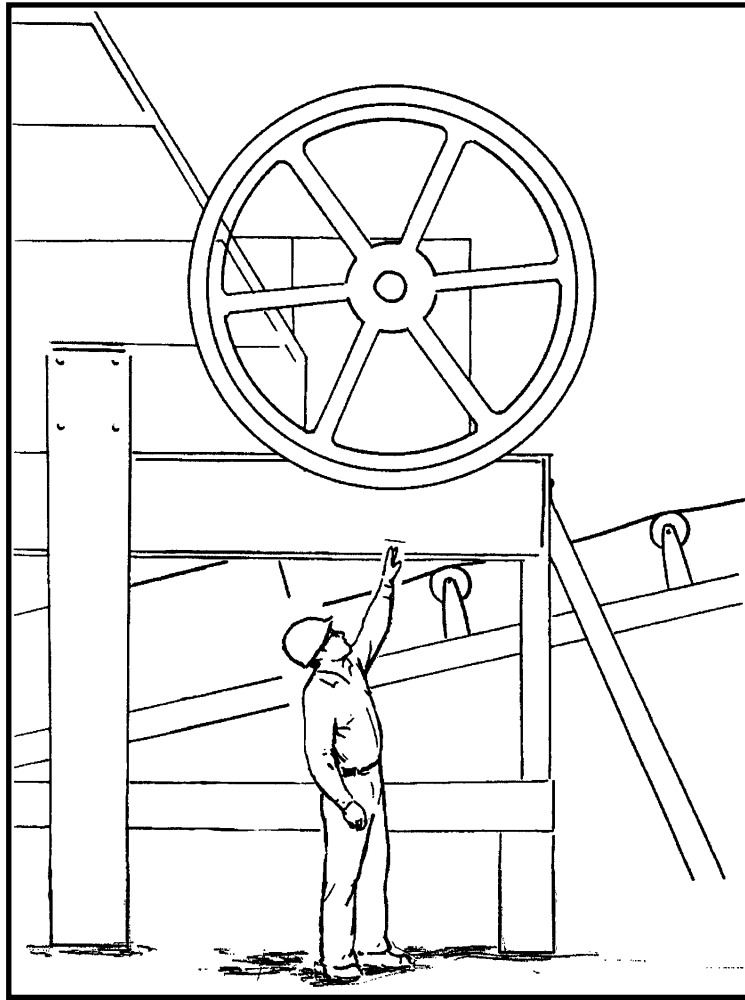


Figure 29

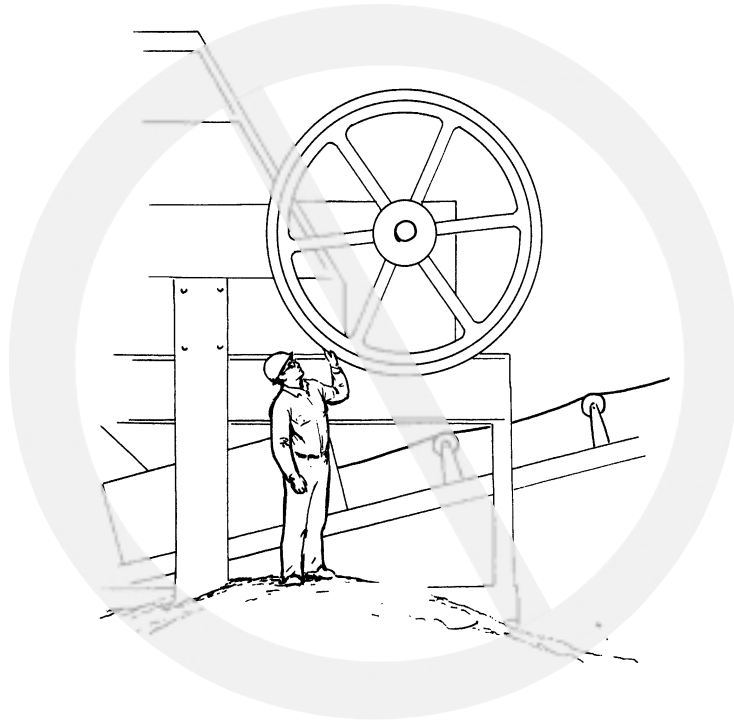


Figure 30

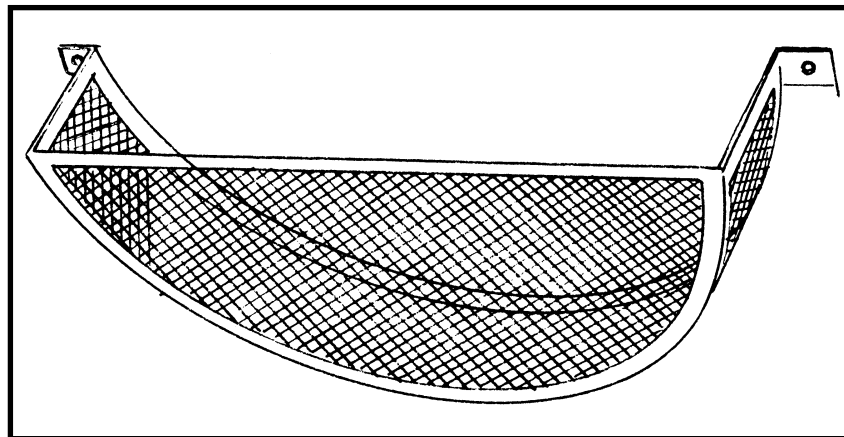


Figure 31

# **FIGURE 32**

Figure 32 shows classifiers guarded to prevent persons from coming in contact with the screws.

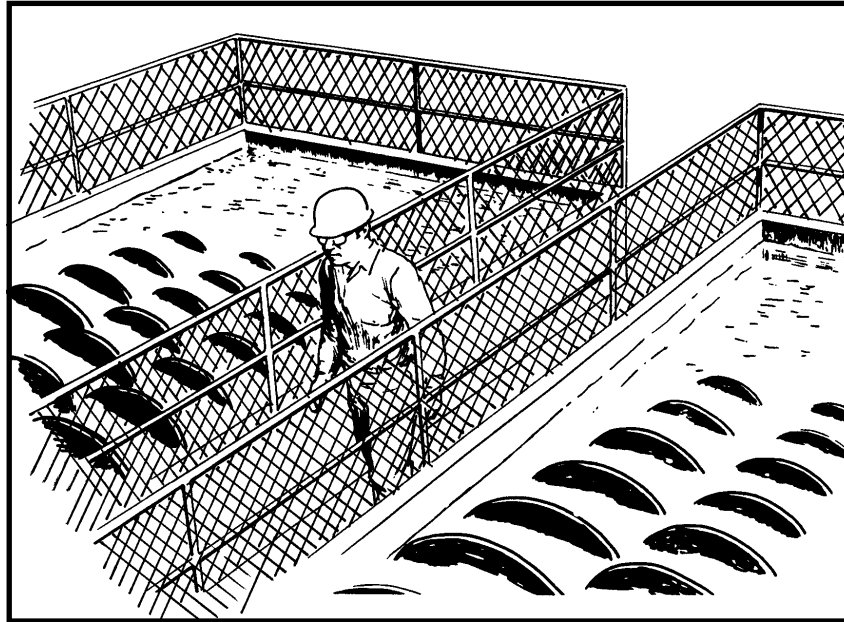
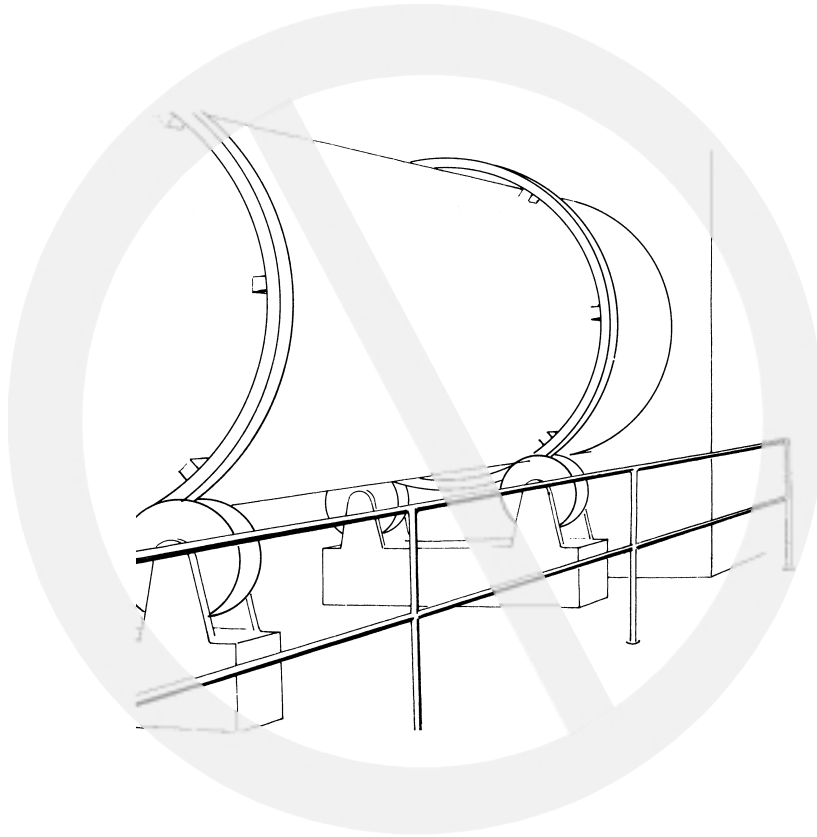


Figure 32

### **FIGURES 33 and 34**

Figure 33 shows a dryer or kiln with a railing restricting access to the area. This should not be considered as a guard, since moving machine parts are exposed and present a hazard to persons. Trunnions can be guarded in a practical manner as shown in Figure 34.



**Figure 33**



Figure 34 shows the trunnions with individual guards. This is an effective way to cover the moving machine parts. The grease fittings can be extended through the guard, so servicing can be done while the dryer is in motion.

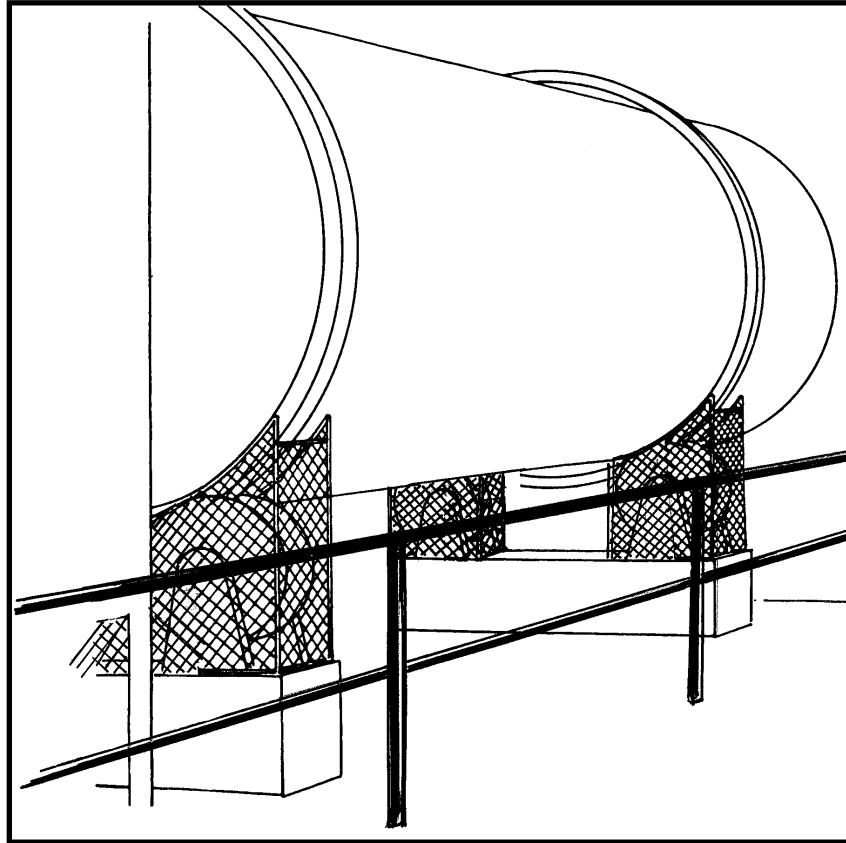


Figure 34

## FIGURES 35 and 36

### Examples of Area Guards

Figure 35 shows an example of an "area guard" intended to protect multiple belt tailpieces. **This guarding is not acceptable** for two reasons: first, there's room for a person to get between the guard and the moving parts; and second, the belts are independently controlled, so while one unit is locked out, the other unit could be started. Multiple tailpieces must be guarded separately, as shown in Figure 36.

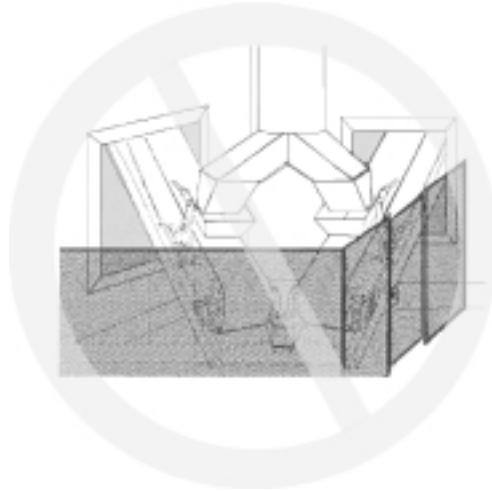


Figure 35

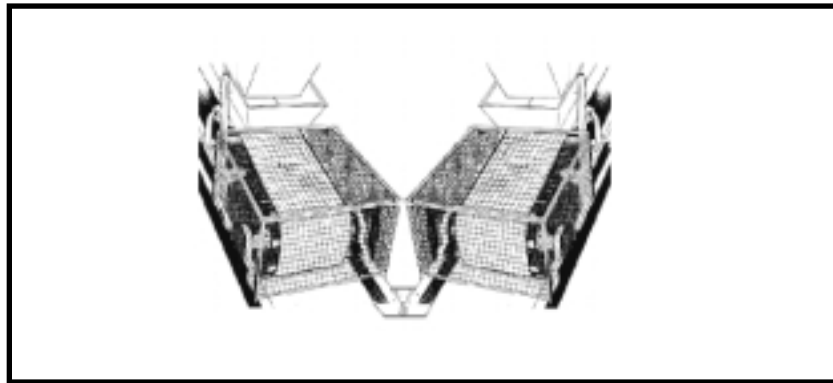


Figure 36

FIGURES 37 and 38

Figure 37 is another example of an area guard. In this example, two separately controlled conveyors are guarded by one guard. Each conveyor is required to have its own guard. A miner working on one conveyor could be exposed to hazards created by the moving machine parts of the other conveyor.

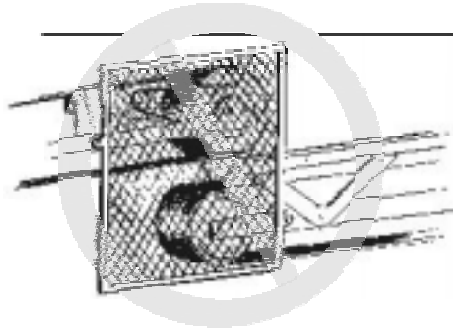


Figure 37

Figure 38 shows a handrail limiting access to the moving machine parts, but this does not totally prevent access to the hazards.

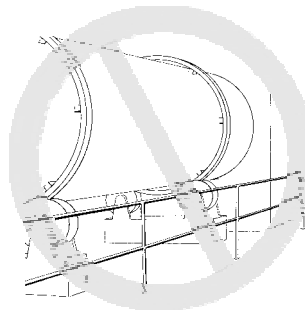


Figure 38

FIGURES 39, 40, and 41

Figure 39 shows an area guard which covers more than one moving machine part controlled by one component. However, the guard is large enough that a miner could place any part of his/her body between the guard and the moving machine parts. Figure 40 shows an acceptable method of guarding. The guard has been designed as close as feasibly possible to the moving machine parts and eliminates the possibility of someone getting between those parts and the guard. Figure 41 shows a similar head pulley with a guard built closer to the moving parts; a miner could not put any part of his/her body between the guard and the moving machine parts.

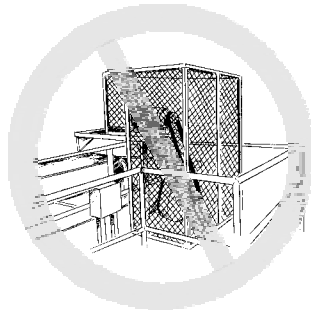


Figure 39

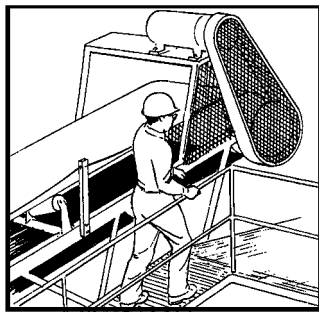


Figure 41

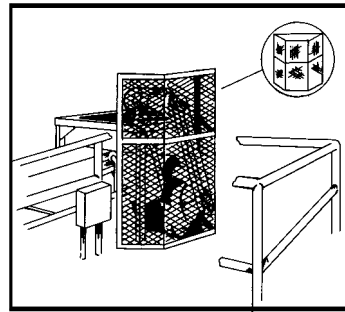


Figure 40

FIGURE 42

Moving machine parts on mobile equipment may need to be guarded to prevent contact during inspection and maintenance activities. For example, Figure 42 shows a guard provided for the engine area of a front-end loader. The guard is needed to prevent contact with the fan and alternator area.

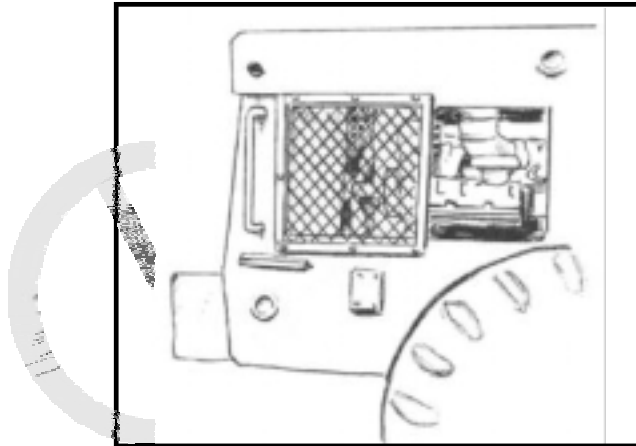


Figure 42